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54 **Electrically conductive adhesive sheet.**

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## Description

The present invention relates to an electrically conductive adhesive sheet to make conductive connections by heat and pressure, wherein conductive metal particles are embedded in a thermosetting adhesive.

5 In the last years electronic equipment and electronic parts have been made compact, and in association therewith it has been required to connect a plurality of conductive track patterns arranged on a circuit board, e.g., flexible circuit board or rigid circuit board at a fine pitch with another conductive track patterns arranged similarly on another flexible substrate for example at a fine pitch corresponding to the former conductive track patterns, or with a plurality of conductors such as lead terminals for IC, etc. arranged at a fine pitch.  
10 Such a connection as above is normally carried out by a so-called wire bonding with use of a gold wire, etc., or a soldering in association with dipping in solder, for example.

However, the wire bonding with use of the gold wire causes an awkward connection working and increase in cost because the gold wire itself is high in cost and collective connection of the wire is impossible. Further, there occurs a problem in reliability such that each of the wire is brought into contact  
15 owing to a fine pitch of a plurality of connection parts, or a connecting strength of bonding parts is reduced and the connection parts are short-circuited owing to reduction in width of the bonding pads.

In case of the dipping in solder, there similarly occurs a problem in reliability such that a solder is flown from the connection parts to cause an accident such as short-circuit between the connection parts due to a fine pitch thereof.

20 Further, there is another connecting method with use of a so-called zebra connector. According to the connecting method, insulators and conductors are alternately layered at a predetermined pitch to form a connector, which is in turn electrically interposed between conductors to be connected with each other and is mechanically pressed on both sides of the conductors to hold the connector. However, the zebra connector itself has no function to mechanically fix the conductors, and therefore it is difficult to maintain a  
25 predetermined width with a uniform pressure.

Further, there has been proposed another connection method wherein an adhesive layer prepared by alternately and stripedly coating a conductive hot-melt adhesive containing carbon fibers and an insulating hot-melt type adhesive is interposed between conductive track patterns and the corresponding conductors. However, reduction of a width of such a stripe as above is limited, and therefore this method is not suitable  
30 for connection of the conductive track patterns having a fine pitch. Further, it is awkward to manufacture such an adhesive layer.

Still another method is disclosed in Japanese Patent Publication 2223/72 published on Jan. 21, 1972. According to this method, wiring patterns are formed through a thermoplastic adhesive material on a substrate, and both substrates are bonded by heating under pressure with the melted adhesive material.  
35 However, there occurs a problem in reliability such that when the adhesive material is melted by heating, the wiring patterns are moved to cause a short-circuit between the patterns. Therefore, it is impossible to satisfactorily make the patterns with a fine pitch and a high density. At this time, as both the substrate are required to be bonded by deformation due to bending of the substrates, at least one of the substrates is required to be flexible. Additionally, there occurs a problem in reliability such that when a spacing of the  
40 patterns is small, sufficient bonding strength cannot be obtained, or in the case that patterns made of Cu foil are bonded to the substrate, a sufficient amount of adhesive material for filling a space between the patterns and bonding both the substrates cannot be obtained.

It is also known to use a connecting sheet 1 as shown in Fig. 1. The connecting sheet 1 comprises a releasing sheet 5 and an adhesive layer 4 containing an electrically conductive fiber 3 such as carbon fiber  
45 arranged in one direction in an insulating adhesive material 2, which layer 4 is applied on the releasing sheet 5. The electrically conductive fiber 3 is mixed in an amount of 5-20 parts by volume, for example, with respect to 100 parts of volume of the adhesive material 2. A thickness of the sheet-like conductive layer 4 is set to 20-120 microns under unused condition prior to electrical connection of wirings as hereinafter described. A carbon fiber having a diameter of 5-50  $\mu\text{m}$  and a length of 0.05-3 mm, for example,  
50 is used as the electrically conductive fiber.

As shown in Fig. 2 which is an enlarged plan view of Fig. 1 and as shown in Fig. 3 which is a cross section taken along the line A-A in Fig. 2, connection with use of the connecting sheet 1 is carried out by laying a plurality of conductive track patterns on another conductors, and interposing the insulating adhesive layer 4 as peeled off from the releasing sheet 1. In this example where a plurality of conductive track  
55 patterns 6 attached and arranged on a rigid substrate 8 are connected to the corresponding conductors 7, e.g., conductive track patterns attached and arranged on a flexible substrate 9, both the substrates 8 and 9 are layered in such a manner that both the conductive track patterns are extended in the same direction at connection parts thereof and are almost registered with each other. Then, as shown in Fig. 4 which is a

cross section taken along the line B-B in Fig. 2, the adhesive sheet 5 of the connecting sheet 1, that is, the adhesive layer 4 containing an electrically conductive fiber 3 dispersed in the adhesive material 2, is provided over the layered parts of the conductive track patterns 6 and the conductors 7 in such a manner that the conductive fiber 3 is extended along the conductive patterns and the conductors 7. Then, both the  
 5 substrates 8 and 9 are bonded as shown by arrows (a) and (b) by heating under pressure application from outside thereof. Thus, as shown in Fig. 5, the conductive track patterns 6 and the corresponding conductors 7 are electrically connected with each other by the conductive fiber 3. Further, the conductive fibers 3 are electrically insulated from each other by the adhesive material 2, and accordingly if a diameter of the conductive fiber 3 is set to a value sufficiently smaller than a spacing between adjacent connected portions,  
 10 electrical connection due to the conductive fibers 3 between the adjacent connected portions may be avoided, and simultaneously both the substrates 8 and 9 may be mechanically strongly bonded with each other by the adhesive material 2.

According to this example, as the conductive track patterns and the corresponding conductors are electrically connected anisotropically in dependence upon direction of the conductive fibers 3, a short-circuit  
 15 between the connected portions may be avoided to improve reliability. In addition, as a plurality of conductive track patterns and the corresponding conductors are simultaneously connected with each other, it is superior in mass production. However, because the electrical connection is carried out through carbon which has a relatively large resistance, there will sometimes occur a problem with respect to high resistance when current flows through the connected portions, though it is not a big problem when mainly voltage is  
 20 applied to the connected portions with small current therethrough.

Such an adhesive material containing the conductive fibers or a connecting method using the adhesive sheet as mentioned above is disclosed in Japanese Published Unexamined Patent Application 138881/81 published Oct. 29, 1981 or European Patent Application Publication No. 0068739 published May 1, 1983.

In GB-A-2 064 233 there is disclosed an electrically conductive sheet to make conductive connections,  
 25 wherein conductive metal particles are embedded in a thermosetting adhesive. Said metal particles are uniformly dispersed in said thermosetting adhesive but only provided in selected portions in the adhesive sheet. These portions correspond to electrical terminals which are to be connected with each other. Therefore the sheet material has to be manufactured in form of dedicated parts for the respective application.

30 It is an object of the present invention to provide a novel electrically conductive adhesive sheet which overcomes the above mentioned drawbacks.

According to the present invention there is provided an electrically conductive adhesive sheet to make conductive connections by heat and pressure, wherein conductive metal particles are embedded in a thermosetting adhesive, characterized in that said metal particles have a melting point lower than a  
 35 predetermined working temperature and being able to being flattened by a predetermined working pressure; and said adhesive sheet contains said particles in form of a uniform dispersion of electrically conductive metal powder the particles of which electrically insulated from each other by the material of said adhesive sheet, said adhesive material being able to be flowed at said working temperature and under said working pressure.

40 Useful embodiments and improvements of the electrically conductive adhesive sheet according to the invention are disclosed in the dependent claims.

The above and other objects, features and advantages of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawing.

Fig. 1 is an enlarged perspective view of an essential part of a conventional connecting sheet for  
 45 explanation of the present invention;

Fig. 2 is an enlarged plan view of an essential part of a conventional circuit board;

Fig. 3 is a cross section taken along the line A-A in Fig. 2;

Figs. 4 and 5 are enlarged cross sections taken along the line B-B in Fig. 2, for explanation of connection between the circuit board and the connecting sheet;

50 Fig. 6 is an exploded and enlarged perspective view of an essential part of a circuit board of a first embodiment according to the present invention;

Figs. 7 and 8 are enlarged sectional views of the essential part of Fig. 6;

Fig. 9 is an enlarged sectional view of a second embodiment according to the present invention;

Fig. 10 is an enlarged perspective view of exemplary parts of a third embodiment;

55 Fig. 11 is an enlarged plan view of a fourth embodiment;

Fig. 12 is a cross section taken along the A-A in Fig. 11;

Fig. 13 is an enlarged perspective view of an exemplary circuit board according to the present invention;

Figs. 14 and 15 are an enlarged sectional view and perspective view, respectively, of an essential part of

a fifth embodiment;

Fig. 16 is an enlarged sectional view of a sixth embodiment of the circuit board;

Figs. 17 and 18 are enlarged sectional views for explanation of a connection mode according to the present invention;

5 Fig. 19 is an exploded perspective view of an exemplary circuit board connection structure according to the present invention; and

Fig. 20 is a perspective view of a connection mode in Fig. 19.

The present invention will be described below in more detail with reference to the preferred embodiments.

10

#### Example 1

As shown in Fig. 6, Cu foil having a thickness of 18 microns attached on a so-called glass cloth epoxy substrate 8, which is a glass cloth substrate impregnated with epoxy resin, was selectively etched to form a plurality of belt-like electrically conductive track patterns 6 arranged in parallel relation with each other at a pitch of 0.2 mm (width of 0.1 mm and spacing of 0.1 mm.) On the other hand, by using a sheet-like flexible substrate 9 having a thickness of 50  $\mu$ m, a plurality of electrically conductive track patterns of Cu foil having the same size as the above-mentioned electrically conductive track patterns 6 were formed as electrical conductors 7. Further, a connecting sheet consisting of a releasing sheet 10 and an adhesive layer 11 coating on the releasing sheet 10 was prepared. The adhesive layer 11 was prepared by using a coating material containing a solder metal powder 13 dispersed in a hot-melt type electrically insulating adhesive material 12. Composition of the insulating adhesive material was as follows:

25	Styrene-butadiene copolymer	.....	50 (parts by weight)
	(Solprene by Asahi Chemical Industry Co., Ltd.)		
30	Terpene phenol resin	.....	50 ( " )
	(YS Polyester T130 by Yasuhara Yushi Kogyo Co., Ltd.)		
35	Toluene	.....	150 ( " )
40	MEK (Methylethylketone)	.....	50 ( " )

A solder metal powder having a low melting point of 10 parts by volume with respect to 100 parts by volume of solid content of the insulating adhesive material was dispersed in the insulating adhesive material having the above composition. A solder metal powder, a melting point of which was set to 140°C by adding Sb and Bi to Pb-Sn alloy, having an average particle size of 20  $\mu$ m was used as the metal powder. The adhesive coating material containing the low melting point solder metal powder 13 dispersed in the insulating adhesive 12 as prepared above was applied on the releasing sheet 10 with a coater so that a thickness of the sheet after dried may be 40 microns to obtain a connecting sheet. Then, the releasing sheet 10 of the connecting sheet as obtained above was peeled off, and the adhesive layer 11 was laid on all the parts of the conductive track patterns 6 on the substrate 8 to be connected to the conductors 7. Then, as shown in Fig. 7, the flexible substrate 9 was laid on the adhesive layer 11 in such a manner that each of the conductors 7 is registered with each of corresponding conductive track patterns 6 through the adhesive layer 11 with respective parts to be connected extending in the same direction. Then, both the substrates were bonded at 180°C under pressure of 40 kg/cm<sup>2</sup> for 30 sec. At this time, as the adhesive material 12 in the adhesive layer 11 is flowed by heating, and the conductive track patterns 6 and the conductors 7 are substantially projected from opposite surfaces of both the substrates 8 and 9, the insulating adhesive material 12 interposed between the conductive track patterns 6 and corresponding conductors 7 is almost expelled sidewardly, and as shown in Fig. 8, the solder metal powder 13 between

the conductive track patterns 6 and the conductors 7 is melted and depressed by heating under pressure, and accordingly the conductive track patterns 6 and the conductors 7 are soldered to each other to be electrically connected. Such a circuit board as prepared above where the conductive track patterns 6 are connected with the conductors 7 had a connection resistance at the connected portions, that is, an actual value of the connection resistance not more than 0.1 ohm between the conductors 7 and the corresponding conductive track patterns 6, while having an insulation resistance not less than  $10^{10}$  ohm between adjacent connected portions. The circuit board was treated by forced aging at  $130^{\circ}\text{C}$  for one week, and thereafter the resistance of the circuit board was measured. Resultantly, the connection resistance was not more than 0.1 ohm, and the insulation resistance was not less than  $10^{10}$  ohm. Thus, there occurred no change in its characteristics.

In this manner, the reason why the connection resistance at the connected portions may be rendered sufficiently small and the insulation resistance between adjacent connected portions may be rendered sufficiently large is considered to result from the fact that the insulating adhesive material 12 which has been rendered largely fluidic by heating under pressure is expelled from an area between the patterns 6 and the conductors 7, and both the members 6 and 7 are well bonded by the molten solder metal powder 13, while the insulating adhesive material 12 as expelled well encloses the metal powder 13 having electrical conductivity, and a large amount of the adhesive material 12 existing between adjacent connected portions serves to strongly fix both the substrates 8 and 9.

## 20 Example 2

In the same procedure as of the Example 1, a circuit board was obtained, except that composition of the insulating adhesive material for the adhesive layer 11 of the connecting sheet was as follows:

25	Acrylic rubber	..... 45 (parts by weight)
	(Teisan Rubber #5001 by	
30	Teikoku Chemical Industry)	
	Epoxy resin	..... 50 ( " )
	(GY 260 by Ciba Geigy Japan)	
35	Polyvinyl phenol	.....4.5 ( " )
	(Resin M by Mauzen Petro-	
40	chemical Co., Ltd.)	
	Undecylimidazole	..... 0.5 ( " )
45	(By Shikoku Fine Chemicals	
	Co., Ltd.)	
	MEK	.....100 ( " )
50	Toluene	.....100 ( " )
	Ethanol	..... 50 ( " )

55 With respect to 100 parts by volume of solid content of the insulating adhesive material as above, 12 parts by volume of solder metal powder (Pb-Sn alloy; melting point of  $230^{\circ}\text{C}$ ) having an average particle size of  $40\text{ }\mu\text{m}$  was mixed and dispersed in the insulating adhesive material to prepare an adhesive coating material, and then the coating material was applied onto the releasing sheet 10 so that a thickness of the

adhesive layer 11 after dried may be 30  $\mu\text{m}$  to obtain a connecting sheet. On the other hand, a polyimide substrate having a thickness of 25  $\mu\text{m}$  was used as the flexible substrate 9. The conductive track patterns 6 on the substrate 8 and the conductors 7 on the substrate 9 were prepared by selectively etching Cu foil having a thickness of 35  $\mu\text{m}$  at a pitch of 1.0 mm (width of 0.5 mm; spacing of 0.5 mm). The releasing sheet 10 on the connecting sheet was peeled off, and the adhesive layer 11 was interposed between the conductive track patterns 6 on the substrate 8 and the conductors 7 on the substrate 9. Then, both the substrates were bonded at 260°C under 50 kg/cm<sup>2</sup> for 15 sec. to obtain a circuit board. The circuit board had a connection resistance not more than 0.1 ohm at connected portions between the conductive track patterns 6 and the conductors 7, while having an insulation resistance not less than 10<sup>10</sup> ohm between adjacent connected portions. Further, after forced aging treatment of the circuit board at 150°C for one week, the connection resistance was not more than 0.1 ohm and the insulation resistance was not less than 10<sup>10</sup> ohm.

Although the above-mentioned examples are applied to connection of each of the wiring patterns on the substrates 8 and 9, they are also applicable to a so-called direct bonding where a terminal conductor on electronic parts, e.g., a semiconductor integrated circuit (IC) is directly, e.g., electrically or mechanically connected and mounted on a so-called film carrier tape or a circuit board which is formed by attaching wiring patterns or circuit wiring patterns for deriving a terminal lead on a flexible substrate.

In the following Example 3, there will be described a case that IC parts are direct-bonded on a film carrier tape.

#### Example 3

As shown in Fig. 9, IC parts 14 having terminal conductors 7 on one surface thereof were bonded on a film carrier tape. The film carrier tape is formed by selectively etching Cu foil having a thickness 18 microns as attached on a flexible substrate 8 of polyimide to make conductive track patterns 6 for deriving a plurality of terminal leads. In this example, a connecting sheet was also prepared. Composition of an insulating adhesive material for the connecting sheet was formulated as follows:

30	Acrylonitrile-butadiene copolymer	..... 70 (parts
	(Hycar 1001 by Nippon Zeon Co., Ltd.)	by weight)
	Phenol resin	..... 70 ( " )
35	(BKR 2620 by Showa Union Gosei Co., Ltd.)	
	MEK	.....300 ( " )

40 With respect to 100 parts by volume of solid content of the insulating adhesive material as above obtained, 7 parts by volume of solder metal powder containing Pb-Sn alloy and an additive of Sb and Bi, having a melting point of 140°C and an average particle size of 20  $\mu\text{m}$  were mixed and dispersed in the insulating adhesive material to obtain an adhesive coating material. Then, the adhesive coating material was applied on a releasing sheet so that a thickness of an adhesive layer after dried may be 10  $\mu\text{m}$ . Then, the releasing sheet on the connecting sheet was peeled off, and the adhesive layer 11 was disposed on a part on the substrate 8 to be bonded to the IC parts 14. Thereafter, the IC parts 14 were laid through the insulating adhesive layer 11 on the conductive track patterns 6 on the substrate 8 for deriving the terminal leads which patterns 6 corresponds to the terminal conductors 17 on the IC parts 14, and then both the members 14 and 8 were bonded at 150°C under 30 kg/cm<sup>2</sup> for 10 sec. In the same manner as in Fig. 8, the terminal conductors 7 on the IC parts 14 and the conductive track patterns 6 for deriving the terminal leads of the film carrier tape are bonded by molten solder metal powder 13 and are electrically and mechanically connected with each other. Simultaneously, the IC parts 14 and the substrate 8 are mechanically connected by the adhesive material filled between adjacent connected portions, and the adjacent connected portions are insulated by the adhesive material.

#### Example 4

Similarly to Example 3, a connecting sheet was employed, however, as shown in Fig. 10, IC parts 14 which are a so-called flat-package IC having a structure such that conductors 7 such as lead legs are derived outwardly projectingly from the IC parts were used. As shown in Figs. 11 and 12, the conductors 7 of the IC parts 14 were layered through an adhesive layer 11 of the connecting sheet onto corresponding conductive track patterns 6 on a substrate 8 or a film carrier tape. Then, a cover film, namely a frame-like cover film 15 formed of a polyimide film and a lower surface of which is coated with an adhesive material 16 was entirely laid on the layered portions, and then the IC parts and the substrate were bonded to each other by heating under pressure to obtain a circuit board. In the circuit board, as similar to the previous examples, the connected portions between the conductive track patterns 6 and the conductors 7 were bonded with molten solder metal powder, and the areas between adjacent connected portions between the cover film 15 and the substrate 8 were filled with the adhesive material 16, which acts to strongly bond both the members 15 and 8, and simultaneously acts to secure electrical insulation between the connected portions.

#### Example 5

Conductive track patterns of Cu foil on flexible substrate formed of polyimide were connected to transparent electrode conductors arranged on a glass substrate at a pitch of 0.4 mm (width of 0.2 mm; spacing of 0.2 mm) with the adhesive layer 11 of the connecting sheet same as in Example 1 interposed therebetween by heating at 180° C under 40 kg/cm<sup>2</sup> for 30 Sec. The transparent electrode conductors were formed of a composite oxide of In and Sn. A gold plating having good affinity to a solder metal was preliminarily attached on the connected portions. Similarly, good electrical connection between the transparent electrode conductors and the conductive track patterns was achieved with a connection resistance not more than 0.1 ohm, while an insulation resistance between adjacent connected portions was maintained at a value not less than 10<sup>7</sup> ohm.

In the previously mentioned examples, the connecting sheet was interposed between the conductive track patterns and the conductors upon bonding, however it is also possible to preliminarily attach an adhesive layer formed by dispersing metal powder in the abovementioned insulating adhesive material directly on the substrate. In this case, the adhesive layer may be employed as a protective film which acts to entirely cover the connected portions of the conductive track patterns on the substrate as well as the other areas including unconnected portions. In another way, the adhesive layer may be locally attached on the areas between each of a plurality of connected portions as arranged.

Attachment of the adhesive layer may be carried out by various methods, for example, by applying the adhesive material with a brush coating or various coaters such as a roll coater and a knife coater, etc., or by sticking a sheet-like adhesive layer onto the substrate.

Such case as above was embodied by the following example.

#### Example 6

40	Polyester resin	..... 60 (parts by weight)
	(Vylon #300 by Toyobo Co., Ltd.)	
45	Polyester	..... 40 ( " )
	(Vylon #200 by Toyobo Co., Ltd.)	
50	Tolune	.....120 ( " )
	MEK	..... 60 ( " )

55 With respect to 100 parts by volume (solid content) of insulating adhesive material having the above composition, 12 parts by volume of low melting point solder powder (containing Pb-Sn alloy and an additive of Sb and Bi) having a melting point of 140° C and an average particle size of 20 μm were mixed and



dispersed in the insulating adhesive material. Then, the insulating adhesive material was entirely applied onto a polyimide substrate having a thickness of 25 microns, on which a plurality of conductive track patterns of Cu foil were arranged at a pitch of 0.4 mm (width of 0.2 mm; spacing of 0.2 mm) so that a thickness after dried may be 30  $\mu\text{m}$ , thus obtaining a circuit board. Then, each one end of the conductive track patterns of the circuit board was layered on the transparent electrodes as mentioned in Example 5, while the other ends were layered on wiring patterns on the other circuit boards, and then were bonded at 180° C under 40 kg/cm<sup>2</sup> for 30 sec. Resultantly, each of the connected portions exhibited good electrical connection.

#### Example 7

15	Acrylic rubber (Tesan Rubber #5001 by Teikoku Chemical Industry)	..... 45 (parts by weight)
20	Epoxy resin (GY 260 by Ciba Geigy Japan)	..... 50 ( " )
25	Polyvinyl phenol (Resin M by Maruzen Petro- chemical Co., Ltd.)	..... 4.5 ( " )
30	Undecylimidazole (By Shikoku Fine Chemicals Co., Ltd.)	..... 0.5 ( " )
35	MEK	..... 100 ( " )
	Toluene	..... 100 ( " )
40	Ethanol	..... 50 ( " )

With respect to 100 parts by volume of solid content of insulating adhesive material having the above composition, 16 parts by volume of solder metal powder (melting point of 230° C) having an average size of 40  $\mu\text{m}$  were mixed and dispersed in the insulating adhesive material to obtain an adhesive coating material. The coating material was applied onto a releasing sheet so that a thickness of an adhesive layer 11 may be 30  $\mu\text{m}$ . The adhesive layer 11 was laid on a glass epoxy substrate 8 formed by impregnating glass fibers with epoxy resin in such a manner that conductive track patterns 6 as formed by etching Cu foil attached on the glass epoxy substrate 8 were entirely covered with the adhesive layer 11, and then was stuck onto the substrate 8 at 100° C as shown in Fig. 13. The releasing sheet is peeled off, and as mentioned in Example 3, the IC parts 14 were direct-bonded onto the patterns on the substrate at 200° C under 50 kg/cm<sup>2</sup> for 15 sec. Similarly, good connection was achieved.

#### Example 8

	Polyester (Vylon #300)	..... 60 (parts by weight)
5	Polyester (Vylon #200)	..... 40 ( " )
	Xylene	..... 80 ( " )
	MEK	..... 20 ( " )

10

With respect to 100 parts by volume (solid content) of insulating adhesive material having the above composition, 10 parts by volume of low m.p. solder metal powder having a melting point of 150 °C and an average particle size of 10  $\mu$ m were mixed and dispersed in the insulating adhesive material. Then, an adhesive layer formed of the insulating adhesive material was selectively attached on connected portions between conductive track patterns of Cu foil and parts leads on a polyimide flexible substrate of 25  $\mu$ m thickness having the conductive track patterns thereon by using a silk screen printing technique. In the same manner as of Example 3, the IC parts were laid through the adhesive layer on the substrate, and were direct-bonded to the substrate at 200 °C under 40 kg/cm<sup>2</sup> for 10 sec. Similarly, good connection was achieved.

#### Example 9

An oxide transparent conductive film (thickness of 1000Å) formed of composite oxide composed of indium oxide and tin oxide was patterned on a transparent glass substrate to provide transparent striped electrode patterns as arranged in parallel relation with each other. On the other hand, a copper foil of 18 microns thickness formed on a polyimide flexible substrate of 25  $\mu$ m thickness was etched by a photolithography method to form striped conductive track patterns corresponding to external lead connections of the above transparent conductive film. In this case, each of pitches of the transparent electrode patterns and the conductive track patterns was set to 0.4 mm (pattern width of 0.2 mm; pattern spacing of 0.2 mm).

In a coating material having the following composition, 110 parts by weight of solder alloy metal powder (m.p. 145 °C; particle size 20 microns) compounding 30 parts by weight of Tb, 45 parts by weight of Sn, 20 parts by weight of Cd, 3 parts by weight of Zn, and 2 parts by weight of Sb was uniformly dispersed.

35

	Acrylonitrile-butadiene copolymer..... 58 (parts by weight)
	(Hycar 1001 by Nippon Zeon Co., Ltd.)
40	Epoxy acrylate
	..... 40 ( " )
	(Lipoxyl SP520X by Showa Highpolymer Co., Ltd.)
45	Organic peroxide
	..... 2 ( " )
	(Perhexa 2M by Nippon Oil & Fat Co., Ltd.)
50	MEK
	.....100 ( " )
	Toluene
	.....100 ( " )

The coating material containing the abovementioned metal powder was applied to a releasing sheet so that a thickness after dried may be 30  $\mu$ m to obtain a sheet-like adhesive layer. The sheet-like adhesive layer was interposed between the transparent electrode patterns and the conductive track patterns between both the substrates, and then both the substrates were bonded at 180 °C under 40 kg/cm<sup>2</sup> for 20 sec. Such

a connection structure where both the patterns were electrically and mechanically connected exhibited good electrical connection.

#### Example 10

In a coating material having the following composition, 110 parts by weight of metal powder having a particle size of 20  $\mu\text{m}$  of solder for glass ceramic bonding (Cerasolzer #143 (m.p. 143°C) by Asahi Glass Co., Ltd.) was mixed and dispersed.

Styrene butadiene rubber	..... 50 (parts by weight)
(Solprene 406 by Asahi Chemical Industry Co., Ltd.)	
Terpene phenol resin	.... 50 ( " )
(YS Polyester T130 by Yasuhara Yushi Kogyo Co., Ltd.)	
Toluene	.....150 ( " )
MEK	..... 50 ( " )

The coating material dispersing the metal powder therein was applied to a releasing paper so that a thickness after dried may be 30  $\mu\text{m}$  to obtain a sheet-like insulating adhesive layer in which the metal powder was dispersed. Then, the releasing paper was peeled off, and the insulating adhesive layer was interposed between both the patterns to be layered with each other in the same manner as in Example 9. Then, both the patterns were bonded at 180°C under 40 kg/cm<sup>2</sup> for 20 sec. Resultantly, a connection resistance at the connected portions of both the patterns was not more than 10 ohm, while an insulation resistance at the areas between adjacent connected portions of both the patterns was not less than 10<sup>10</sup> ohm. Further, even after a forced aging treatment at 100°C for one week, the connection resistance was not more than 10 ohm, and the insulation resistance was not less than 10<sup>10</sup> ohm.

#### Example 11

In the coating material, 80 parts by weight of metal powder having a particle size of 10  $\mu\text{m}$  of solder for glass ceramic bonding (Cerasolzer #123 (m.p. 123°C) by Asahi Glass Co., Ltd.) were uniformly mixed and dispersed to obtain an adhesive coating material, and then the adhesive coating material was applied to a releasing paper so that a thickness after dried may be 20  $\mu\text{m}$  to obtain an insulating adhesive layer in which the metal powder was dispersed. Then, the sheet-like insulating adhesive layer was separated from the releasing paper, and was interposed between the transparent electrode patterns and the conductive track patterns in the same manner as in Example 9 to bond both the patterns at 150°C under pressure of 40 kg/cm<sup>2</sup> for 20 sec. In this example, each of pitches of the transparent electrode patterns and the conductive track patterns was set to 0.3 mm (pattern width of 0.15 mm; pattern spacing of 0.5 mm). In this case, even after a forced aging treatment at 80°C and relative humidity of 95% for one week, there occur red no change in electrical connection resistance and insulation resistance.

#### Example 12

A sheet-like adhesive layer including the same metal powder as in Example 10 was used, except that the composition of an adhesive material was formulated as follows:

5	Acrylic rubber (Tesan Rubber #5001 by Teikoku Chemical Industry)	..... 30 (Parts by weight)
10	Epoxy resin (GY 260 by Ciba Geigy Japan)	..... 60 ( " )
15	Polyvinyl phenol (Resin M by Maruzen Petrochemical Co., Ltd.)	.....9.5 ( " )
20	Undecylimidazole (by Shikoku Fine Chemicals Co., Ltd.)	.....0.5 ( " )
25	MEK	.....100 ( " )

The insulating adhesive layer as obtained containing dispersed metal powder was interposed between both the patterns to be connected in the same manner as in Example 9, and was bonded at 300° C and 60 KHz under pressure of 30 kg/cm<sup>2</sup> for 30 sec. by using an ultrasonic soldering device (Sunbonder by Asahi Glass Co., Ltd.). As the result, a connection resistance at the connected portions was not more than 5 ohm, and an insulation resistance between adjacent connected portions was not less than 10<sup>10</sup> ohm.

#### Example 13

A rigid substrate and flexible substrate similar to those in Example 1 were connected with each other by using a connecting sheet, wherein a pattern pitch was 0.3 mm (pattern width of 0.15 mm; pattern spacing of 0.15 mm).

The adhesive layer 11 of the connecting sheet 12 was prepared by dispersing a low m.p. melting point solder metal powder in a hot-melt type insulating adhesive material. Composition of the insulating adhesive material was as follows:

45	Styrene-butadiene copolymer (Cariflex TRKX-65 by Shell Kagaku Kabushiki Kaisha)	..... 60 (parts by weight)
50	Terpene phenol resin (YS Polyster T115 by Yasuhara Yushi Kogyo Co., Ltd.)	..... 40 ( " )
55	Toluene	.....150 ( " )
	MEK	..... 50 ( " )

In the insulating adhesive material having the above composition, 100 parts by weight of low melting point solder metal powder was mixed so as to be uniformly dispersed therein. The metal powder was

obtained by grinding Pb-Sn-Cd alloy in atmosphere with a grinder to an average particle size of 30  $\mu\text{m}$ . An insulating oxide film was formed on a surface of the low melting point solder metal powder. A melting point of the Pb-Sn-Cd alloy was 143 °C. An adhesive coating material as obtained by dispersing the low melting point solder metal powder in the insulating adhesive material was applied onto a releasing sheet so that a thickness after dried may be 40  $\mu\text{m}$  to obtain the connecting sheet. Then, the releasing sheet was peeled off from the connecting sheet, and the adhesive layer was entirely laid on at least areas where the conductors were to be connected with the conductive track patterns on the substrate, and then as shown in Fig. 7, the flexible substrate 9 was laid on the lower substrate 8 in such a manner that the conductors 7 were layered through the adhesive layer 11 on the corresponding conductive track patterns 6 and that the connected portions were extended in the same direction. Then, both the substrates were bonded at 180 °C under pressure of 40 kg/cm<sup>2</sup> for 20 sec. At this time, as the adhesive material in the adhesive layer 11 is flowed by heating, and the conductive track patterns and the conductors 7 are substantially projected from opposite surfaces of both the substrates 8 and 9, the insulating adhesive material interposed between the conductive track patterns 6 and corresponding conductors 7 is almost expelled sidewardly, and as shown in Fig. 8, the low melting point solder metal powder 13 between the conductive track patterns 6 and the conductors 7 is melted and depressed by heating under pressure. At this time, the oxide film formed on the surface of the low melting point solder metal powder 13 is broken by pressure, and accordingly the conductive track patterns 6 and the conductors 7 are soldered to each other to be electrically connected. Such a circuit board as prepared above where the conductive track patterns 6 are connected with the conductors 7 had a connection resistance at the connected portions, that is, an actual value of the connection resistance of 0.08 ohm between the conductors 7 and the corresponding conductive track patterns 6, while having an insulation resistance of  $1.5 \times 10^{11}$  ohm between adjacent connected portions. In this case, the insulating oxide film is formed on the surface of the low melting point solder metal powder 13, and accordingly even if any solder metal powder which has not been molten and depressed was in contact with each other, an electrical resistance was remarkably large enough to be regarded as substantially insulated condition. The circuit board was treated by forced aging at 80 °C and relative humidity of 95% for one week, and thereafter the resistance of the circuit board was measured. As the result, the connection resistance was 0.1 ohm, and the insulation resistance was  $8.0 \times 10^9$  ohm. Thus, even after such hard aging, its characteristics was kept satisfactorily.

In this manner, the reason why the connection resistance at the connected portions may be rendered sufficiently small and the insulation resistance between adjacent connected portions may be rendered sufficiently large is considered to result from the fact that the insulating adhesive material which has been rendered largely fluidic by heating under pressure is expelled from an area between the patterns 6 and the conductors 7, and both the members 6 and 7 are well bonded by the molten solder metal powder 13 after the oxide film thereon being broken, while the insulating adhesive material as expelled well encloses the metal powder 13 having electrical conductivity, and a large amount of the adhesive material existing between adjacent connected portions serves to strongly fix both the substrates 8 and 9.

#### Example 14

In Fig. 16, reference numeral 21 designates a so-called glass cloth epoxy substrate, and Cu foil of 18 microns thickness attached on the glass cloth epoxy substrate 21 was selectively etched to form a plurality of band-like conductive track patterns 22 as arranged in parallel relation with each other at a pitch of 0.3 mm (width of 0.15 mm; spacing of 0.15mm), thus preparing a circuit board. A low melting point solder metal powder 24 having an oxide film as formed thereon was dispersed in a hot-melt type insulating adhesive material 23 to prepare an adhesive coating material, and then the coating material was applied onto the conductive track patterns 22 to form an adhesive layer 25. The insulating adhesive material 23 has the same composition as in Example 13. In the insulating adhesive material 23 having the composition, 100 parts by weight of the low melting point solder metal powder 24 was mixed and uniformly dispersed. The metal powder is the same as in Example 13. The adhesive coating material containing the low melting point solder metal powder 24 dispersed in the insulating adhesive material 23 was applied onto the conductive track patterns 22 with a coater so that a thickness after dried may be 40  $\mu\text{m}$  to form an adhesive layer 25, and then a releasing paper 26 was attached on the adhesive layer 25.

As shown in Fig. 17, when the conductive track patterns 22 are electrically connected to another conductive patterns 28 formed of Cu foil having the same size as that of the conductive track patterns 22 on a sheet-like polyimide flexible substrate 27 having a thickness of 50  $\mu\text{m}$ , the releasing paper 26 is peeled off, and the conductive track patterns 22 and 28 on the substrates 21 and 27 are registered with each other, and are bonded at 180 °C under 40 kg/cm<sup>2</sup> for 20 sec. At this time, as the adhesive material 23 in the

adhesive layer 25 is flowed by heating as shown in Fig. 18, and the conductive track patterns 22 and 28 are substantially projected from opposite surfaces of both the substrates 21 and 27, the insulating adhesive material 23 interposed between the conductive track patterns 22 and 28 is almost expelled sidewardly, and the low melting point solder metal powder 13 between the conductive track patterns 22 and 28 is melted and depressed by heating under pressure. At this time, the oxide film formed on the surface of the low melting point solder metal powder 24 is broken by pressure, and accordingly the conductive track patterns 22 and 28 are soldered to each other to be electrically connected. Such a circuit board as prepared above where the conductive track patterns 22 and 28 are connected with each other had a connection resistance at the connected portions, that is, an actual value of the connection resistance of 0.08 ohm between the conductive track patterns 22 and the corresponding conductive track patterns 28, while having an insulation resistance of  $1.5 \times 10^{11}$  ohm between adjacent connected portions. In this case, the insulating oxide film is formed on the surface of the low melting point solder metal powder 24, and accordingly even if any solder metal powder which has not been molten and depressed was in contact with each other, an electrical resistance was remarkably large enough to be regarded as substantially insulated condition. The circuit board was treated by forced aging at 80°C and relative humidity of 95% for one week, and thereafter the resistance of the circuit board was measured. As the result, the connection resistance was 0.1 ohm, and the insulation resistance  $8.0 \times 10^9$  ohm. Thus, even after the aging, its characteristics was kept satisfactorily.

Referring next to Figs. 19 and 20 which show a connecting mode where a liquid crystal display panel 29 having a plurality of terminals 29a is to be connected through a flexible substrate 31 to an IC 30 for driving the liquid crystal display panel 29, corresponding parts in Figs. 16 to 18 are designated by the same reference numerals, and description relating thereto will be omitted.

Cu foil having a thickness of 18 microns was selectively etched on an insulating flexible substrate 31a of a polyimide film having a thickness of 25  $\mu\text{m}$  to form a plurality of band-like conductive track patterns 22 arranged at a pitch of 0.4 mm, and then an adhesive layer 25 containing an insulating adhesive material having the following composition was entirely attached on the conductive track patterns 22 so that a thickness after dried may be 30  $\mu\text{m}$  to form a flexible circuit board 31.

30	Acrylic rubber	..... 30 (parts by weight)
	(Teisan Rubber #5001 by Teikoku Chemical Industry)	
35	Epoxy resin	..... 60 ( " )
	(GY 260 by Ciba Geigy Japan)	
	Polyvinyl phenol	.....9.5 ( " )
40	(Resin M by Maruzen Petrochemical Co., Ltd.)	
	Undecylimidazole	.....0.5 ( " )
45	(By Shikoku Finechemicals Co., Ltd.)	
	MEK	.....100 ( " )

A solder for glass ceramic bonding (Cerasolzer #123 by Asahi Chemical Industry Co., Ltd.) was ground in the air by using a grinder to an average particle size of 20  $\mu\text{m}$  to prepare a solder metal powder 24, and then 120 parts by weight of the solder metal powder 24 was mixed and uniformly dispersed in the insulating adhesive material having the composition. In this case, as the solder for glass ceramic bonding is ground in the air, an insulating oxide film is formed on a surface of the solder metal powder 24. A melting point of the glass ceramics bonding solder is 145°C.

One end of the flexible circuit board 31 was laid on the liquid crystal display panel 29 in such a manner that the conductive track patterns 22 of the circuit board 31 were oppositely laid through the adhesive layer 25 onto transparent electrodes (ITO) 29a arranged at a pattern pitch of 0.4 mm on the liquid crystal display

panel 29. On the other hand, the other end of the flexible circuit board 31 was laid on a glass epoxy substrate 41 in such a manner that the conductive track patterns 22 were oppositely laid on connection terminals 32a formed on the glass epoxy cloth substrate 41 corresponding to the predetermined conductive track patterns 22. Then, as shown in Fig. 20, such layered portions were bonded at 150 °C under 50 kg/cm<sup>2</sup> for 15 sec. Resultantly, good electrical connection was achieved as described above. According to this example, it is advantageously possible to easily carry out electrical connection between a plurality of the conductive track patterns 22 and 29a as well as electrical connection between a plurality of the conductive track patterns 22 and 32a. Simultaneously, it is advantageously possible to mechanically connect both the substrates with the adhesive material 23. Further, since the adhesive material 23 of the adhesive layer 25 attached on the conductive track patterns 22 is an insulating material, and an insulating oxide film is formed on the surface of the solder metal powder 24, the adhesive layer 25 serves to insulate the conductive track patterns 22 from each other at unconnected portions and also serves to protect the conductive track patterns 22.

Next, in case of connection between the IC 30 and the glass cloth epoxy substrate 41 at a predetermined position, Cu foil having a thickness of 9 μm was preliminarily etched on the glass epoxy substrate 41 to form a predetermined conductive track patterns. Then, as shown in Fig. 19, an adhesive layer 25 as formed into a substantial square was attached on the connection terminals 32b of the conductive patterns on the IC 30. The adhesive layer 25 contains an insulating adhesive material having the following composition.

20

Acrylonitrile-butadiene copolymer..... 60 (parts by weight)

25

(Hycar 1001 by Nippon Zeon Co., Ltd.)

Phenol resin ..... 40 ( " )

(BKR 2620 by Showa Union Gosei Co., Ltd.)

30

MEK .....300 ( " )

A low melting point solder (Pb-Sn-Cd alloy; melting point 143 °C) was ground in the air by using a grinder to an average particle size of 10 μm to prepare a low melting point solder metal powder 24 having an insulating oxide film on a surface thereof, and then 150 parts by weight of the metal powder was mixed and dispersed in the insulating adhesive material having the above composition.

The IC connection terminals 32b on the substrate 41 were registered through the adhesive layer 25 with terminals of the flat-package IC 30, and the registered portions were bonded at 180 °C under 40 kg/cm<sup>2</sup> for 10 sec. Similarly, good electrical and mechanical connection were achieved.

Although the above-mentioned example discloses that the adhesive layer 25 is directly attached on the circuit board, it should be appreciated that the adhesive layer 25 is attached on a releasing paper and the releasing paper having the adhesive layer 25 is attached on an entire surface or a predetermined part of the circuit board. Further, it should be appreciated that various modifications of the present invention may be permitted without departing from the scope of the invention.

As is above described, it will be understood that the present invention discloses a connection structure between a plurality of conductive track patterns such as wiring patterns and terminal deriving lead patterns and corresponding similar wiring patterns or conductors such as terminals and lead legs. In order to secure a mechanical strength of two substrates, a substrate and parts, or a substrate and a cover film interposing the wiring patterns and conductors therebetween and bonded with an adhesive layer filled in a space therebetween, and also secure an insulation resistance between adjacent connected portions of the patterns and conductors, it is preferred to use a flexible material for at least one of the substrates or the cover film interposing the space, so that the space may be substantially fully filled with the insulating adhesive layer.

Furthermore, for purpose of secured reinforcement of the connection structure, a reinforcing adhesive resin 17 may be applied to a whole or part of an outer peripheral edge of the connected portions as arranged of a plurality of conductive track patterns 6 and conductors 7 as required, as shown in Figs. 14 and 15.

Furthermore, in the case that it is preferred to use a soldering flux in bonding with the solder metal in the adhesive material 11, the flux may be contained in the coating material for the adhesive layer, or the

metal powder may be preliminarily enclosed by the flux, or the flux may be applied to a surface of the conductors or conductive track patterns or a surface of the adhesive layer.

Further, a solder plating may be applied to either or both of the conductive track patterns and the corresponding conductors. However, the solder plating may be sufficiently thin because complete soldering  
5 by the solder plating is not required.

As is above described, since electrical connection between the conductive track patterns and the corresponding conductors is achieved mainly by melt-bonding of metal, connection with low resistance may be secured. Accordingly, the present invention is advantageously applicable to the case of current driving mode where current is conducted through the connected portions. Further, since the areas between  
10 adjacent connected portions are filled with the insulating adhesive material, insulation between the connected portions may be secured even when a high-density wiring is employed where a pitch of the connected portions is greatly fine, thereby improving reliability and establishing a circuit board of higher density and fine pitch pattern.

Further, according to the present invention, an insulating adhesive layer containing a dispersed metal  
15 powder, or solder metal powder having a specific composition is interposed between the transparent electrode patterns of oxide and the corresponding conductive track patterns, and both the transparent electrode patterns and the corresponding conductive track patterns are electrically connected by soldering of the metal powder with heat and pressure, and simultaneously the areas between adjacent patterns are insulated by enclosing the metal powder existing in the areas with the insulating adhesive material.  
20 Accordingly, a connection resistance between the conductive track patterns may be rendered sufficiently small and an electrical insulation between adjacent conductive patterns may be satisfactory. Although it is generally difficult to electrically and mechanically connect a conductive film to a transparent conductive film of oxide, the present invention makes it possible to permit superior electrical and mechanical connection, and thereby to facilitate rendering of finer pitch of the patterns and mass production.

Further, in the case that a metal powder having an insulating film on a surface thereof is used, it is possible to more effectively prevent electrical connection accident between adjacent conductive track patterns, thus achieving more reliable connection.

#### Claims

30

1. An electrically conductive adhesive sheet to make conductive connections by heat and pressure, wherein conductive metal particles are embedded in a thermosetting adhesive, characterized in that  
said metal particles have a melting point lower than a predetermined working temperature and  
35 being able to be flattened by a predetermined working pressure; and  
said adhesive sheet (11, 25) contains said particles in the form of a uniform dispersion of electrically conductive metal powder (13, 24) the particles of which are electrically insulated from each other by the material of said adhesive sheet (12, 23), said adhesive material being able to be flowed at said working temperature and under said working pressure.

40

2. The electrical conductive adhesive sheet according to claim 1, for electrically connecting a first set of a plurality of electrically conductive tracks (6, 22) with a second set of a plurality of electrically conductive tracks (7, 28) to be connected with each of the said electrically conductive tracks of said first set (6, 22), and mechanically integrating said first and said second set of a plurality of electrically conductive  
45 tracks (6, 7, 22, 28),

wherein said metal powder (13, 24) is electrically insulated by said adhesive material (12, 23) and said metal powder (13, 24) has a particle size small enough not to bridge any neighbouring pair of said conductive tracks (6, 7, 22, 28) when flattened by application of said working pressure, said metal powder (13, 24) and said adhesive material (12, 23) being solidified after being cooled to room  
50 temperature.

3. The electrically conductive adhesive sheet according to claim 1 or 2, wherein said metal powder (13, 24) has a melting point between 50° and 350°.

- 55 4. The electrically conductive adhesive sheet according to any one of claims 1 to 3, wherein said metal powder (13, 24) has a melting point between 80° and 260°.

5. The electrically conductive adhesive sheet according to any one of claims 1 to 4, wherein said metal



powder (13, 24) has an insulating layer on a surface of each particle of said metal powder (13, 24).

6. The electrically conductive adhesive sheet according to any one of claims 1 to 5, wherein said metal powder (13, 24) is made of an alloy mainly containing Pb and Sn.
7. The electrically conductive adhesive sheet according to any one of claims 1 to 6, wherein said metal powder (13, 24) is solderable to a transparent conductive electrode made of oxides of indium and tin.
8. The electrically conductive adhesive sheet according to any one of claims 1 to 7, wherein said metal powder (13, 24) is made of an alloy mainly containing Pb and Sn and an additive selected from the group consisting of Zn and rare earth elements.
9. The electrically conductive adhesive sheet according to any one of claims 1 to 8, wherein said adhesive sheet (11, 25) has a thickness of between 5  $\mu\text{m}$  and 200  $\mu\text{m}$ .
10. The electrically conductive adhesive sheet according to any one of claims 1 to 9, wherein said adhesive sheet (11, 25) contains 0.5 to 50 parts by volume of said metal powder (13, 24) with respect to 100 parts by volume of said adhesive material (12, 23).
11. The electrically conductive adhesive sheet according to any one of claims 1 to 10, wherein said adhesive material (12, 23) has a melt flow index not smaller than 0.001 at said elevated working temperature.
12. The electrically conductive adhesive sheet according to any one of claims 1 to 11, wherein said adhesive material (12, 23) has a melt flow index not smaller than 0.005 at said elevated working temperature.
13. The electrically conductive adhesive sheet according to any one of claims 1 to 12, wherein said adhesive material (12, 23) has resistivity not less than 10 ohm cm.
14. The electrical conductive adhesive sheet according to claim 1 or 2, wherein the electrically conductive adhesive sheet is a part of a circuit board having an insulating substrate (8, 21), said first set of a plurality of electrically conductive tracks (6, 22) being formed on said substrate (8, 21) and said electrically conductive adhesive sheet (12, 23) being provided on said conductive tracks (6, 22) at least over an area where said second set of a plurality of electrically conductive tracks (7, 28) are to be electrically connected to said first set of conductive tracks (6, 22).
15. The electrical conductive adhesive sheet according to claim 14, wherein said substrate (8, 21) is made of glass.
16. The electrical conductive adhesive sheet according to claim 14 or 15, wherein said adhesive sheet (11, 25) is coated over said first set of a plurality of electrically conductive tracks (6, 22) and said substrate (8, 21).
17. The electrical conductive adhesive sheet according to claim 1 or 2, wherein the electrically conductive adhesive sheet is a part of a electrical connection structure, said first set of a plurality of electrically conductive tracks (6, 22) being formed on a substrate (8, 21), and wherein said melting and flattening takes place under a surface-contact condition upon application of a certain elevated working temperature higher than a melting point of said metal powder (13, 24) and a certain working pressure is applied between said first and second set of said conductive tracks (6, 7, 22, 28), said adhesive material (12, 23) being melted, flowed and partly expelled between said first and second set of electrically conductive tracks (6, 7, 22, 28) to mechanically integrate said first and second set of electrically conductive tracks (6, 7, 22, 28).
18. The electrical conductive adhesive sheet according to claim 17, wherein said second set of a plurality of electrically conductive tracks (7, 28) is formed on a semiconductor integrated circuit chip (14, 30).
19. The electrical conductive adhesive sheet according to claim 17 or 18, wherein said second set of a

plurality of electrically conductive tracks (7, 28) is a plurality of lead electrodes of electronic parts.

20. The electrical conductive adhesive sheet according to any one of claims 17 to 19, wherein said electronic parts are a semiconductor integrated circuit chip (14, 30).

21. The electrical conductive adhesive sheet according to claim 19 or 20, further comprising a flexible sheet covering connection portions of said first and second tracks.

# Revendications

1. Feuille adhésive conductrice de l'électricité destinée à la réalisation de connexions conductrices par chauffage et compression, dans laquelle des particules métalliques conductrices sont enrobées dans un adhésif thermodurcissable,

caractérisée en ce que :

les particules métalliques ont une température de fusion inférieure à une température prédéterminée de travail et peuvent s'aplatir sous l'action d'une pression prédéterminée de travail, et

la feuille adhésive (11, 25) contient les particules sous forme d'une dispersion uniforme d'une poudre métallique conductrice de l'électricité (13, 24) dont les particules sont isolées électriquement les unes des autres par le matériau de la feuille adhésive (12, 23), la matière adhésive pouvant fluer à la température de travail et à la pression de travail.

2. Feuille adhésive conductrice de l'électricité selon la revendication 1, destinée à connecter électriquement un premier ensemble de plusieurs pistes conductrices de l'électricité (6, 22) à un second ensemble de plusieurs pistes conductrices de l'électricité (7, 28) destinées à être connectées à chacune des pistes conductrices de l'électricité du premier ensemble (6, 22), et à rendre mécaniquement solidaires le premier et le second ensemble de plusieurs pistes conductrices de l'électricité (6, 7, 22, 28),

dans laquelle la poudre métallique (13, 24) est isolée électriquement par la matière adhésive (12, 23) et la poudre métallique (13, 24) a une dimension particulière suffisamment petite pour qu'elle ne forme pas un pont entre les pistes conductrices voisines (6, 7, 22, 28) d'une paire quelconque de pistes adjacentes, lorsqu'elle est aplatie par application de la pression de travail, la poudre métallique (13, 24) et la matière adhésive (12, 23) étant solidifiées après refroidissement à température ambiante.

3. Feuille adhésive conductrice de l'électricité selon la revendication 1 ou 2, dans laquelle la poudre métallique (13, 24) a une température de fusion comprise entre 50 et 350 °C.

4. Feuille adhésive conductrice de l'électricité selon l'une quelconque des revendications 1 à 3, dans laquelle la poudre métallique (13, 24) a une température de fusion comprise entre 80 et 260 °C.

5. Feuille adhésive conductrice de l'électricité selon l'une quelconque des revendications 1 à 4, dans laquelle la poudre métallique (13, 24) a une couche isolante sur une surface de chaque particule de la poudre métallique (13, 24).

6. Feuille adhésive conductrice de l'électricité selon l'une quelconque des revendications 1 à 5, dans laquelle la poudre métallique (13, 24) est formée d'un alliage contenant essentiellement Pb et Sn.

7. Feuille adhésive conductrice de l'électricité selon l'une quelconque des revendications 1 à 6, dans laquelle la poudre métallique (13, 24) peut être soudée à une électrode conductrice transparente formée d'oxydes d'indium et d'étain.

8. Feuille adhésive conductrice de l'électricité selon l'une quelconque des revendications 1 à 7, dans laquelle la poudre métallique (13, 24) est formée d'un alliage contenant essentiellement Pb et Sn et un adjuvant choisi dans le groupe formé par Zn et les éléments des terres rares.

9. Feuille adhésive conductrice de l'électricité selon l'une quelconque des revendications 1 à 8, telle que la feuille adhésive (11, 25) a une épaisseur comprise entre 5 et 200 µm.

10. Feuille adhésive conductrice de l'électricité selon l'une quelconque des revendications 1 à 9, dans laquelle la feuille adhésive (11, 25) contient 0,5 à 50 parties en volume de la poudre métallique (13, 24) pour 100 parties en volume de la matière adhésive (12, 23).
- 5 11. Feuille adhésive conductrice de l'électricité selon l'une quelconque des revendications 1 à 10, dans laquelle la matière adhésive (12, 23) a un indice d'écoulement à l'état fondu qui n'est pas inférieur à 0,001 à la température élevée de travail.
- 10 12. Feuille adhésive conductrice de l'électricité selon l'une quelconque des revendications 1 à 11, dans laquelle la matière adhésive (12, 23) a un indice d'écoulement à l'état fondu qui n'est pas inférieur à 0,005 à la température élevée de travail.
13. Feuille adhésive conductrice de l'électricité selon l'une quelconque des revendications 1 à 12, dans laquelle la matière adhésive (12, 23) a une résistivité qui n'est pas inférieure à 10  $\Omega$ .cm.
- 15 14. Feuille adhésive conductrice de l'électricité selon la revendication 1 ou 2, telle que la feuille adhésive conductrice de l'électricité fait partie d'une carte de circuit ayant un substrat isolant (8, 21), le premier ensemble de plusieurs pistes conductrices de l'électricité (6, 22) étant formé sur le substrat (8, 21) et la feuille adhésive conductrice de l'électricité (12, 23) étant disposée sur les pistes conductrices (6, 22) au moins sur une zone dans laquelle le second ensemble de plusieurs pistes conductrices de l'électricité (7, 28) est destiné à être connecté électriquement au premier ensemble de pistes conductrices (6, 22).
- 20 15. Feuille adhésive conductrice de l'électricité selon la revendication 14, dans laquelle le substrat (8, 21) est formé de verre.
- 25 16. Feuille adhésive conductrice de l'électricité selon la revendication 14 ou 15, dans laquelle la feuille adhésive (11, 25) est revêtue sur le premier ensemble de plusieurs pistes conductrices de l'électricité (6, 22) et le substrat (8, 21).
- 30 17. Feuille adhésive conductrice de l'électricité selon la revendication 1 ou 2, telle que la feuille conductrice de l'électricité fait partie d'une structure de connexion électrique, le premier ensemble de plusieurs pistes conductrices de l'électricité (6, 22) étant formé sur un substrat (8, 21), et la fusion et l'aplatissement sont réalisés à un état de contact des surfaces par application d'une certaine température élevée de travail supérieure à la température de fusion de la poudre métallique (13, 24) et une certaine pression de travail est appliquée entre le premier ensemble et le second ensemble de pistes conductrices (6, 7, 22, 28), la matière adhésive (12, 23) étant fondue, s'écoulant et étant partiellement chassée entre le premier et le second ensemble de pistes conductrices de l'électricité (6, 7, 22, 28) afin que le premier et le second ensemble de pistes conductrices de l'électricité (6, 7, 22, 28) soient intégrés mécaniquement.
- 40 18. Feuille adhésive conductrice de l'électricité selon la revendication 17, dans laquelle le second ensemble de plusieurs pistes conductrices de l'électricité (7, 28) est formé sur une pastille (14, 30) de circuit intégré à semi-conducteur.
- 45 19. Feuille adhésive conductrice de l'électricité selon la revendication 17 ou 18, dans laquelle le second ensemble de plusieurs pistes conductrices de l'électricité (7, 28) est formé de plusieurs électrodes de connexion de composants électroniques.
- 50 20. Feuille adhésive conductrice de l'électricité selon l'une quelconque des revendications 17 à 19, dans laquelle les composants électroniques sont une pastille de circuit intégré à semi-conducteur (14, 30).
21. Feuille adhésive conductrice de l'électricité selon la revendication 19 ou 20, comprenant en outre une feuille souple recouvrant les parties de connexion des premières et secondes pistes.

#### 55 Patentansprüche

1. Elektrisch leitende klebende Folie zur Herstellung von leitenden Verbindungen durch Hitze und Druck, wobei leittfähige Metallteilchen in einen wärmehärtenden Kleber eingebettet sind, dadurch gekennzeichnet-

- net, daß die Metallteilchen niedriger Schmelzen als dies einer vorgegebenen Arbeitstemperatur entspricht und die Eigenschaft haben, bei einem vorgegebenen Arbeitsdruck abgeflacht zu werden, und daß die klebende Folie (11, 25) die Teilchen in Form einer gleichmäßigen Verteilung der elektrisch leitfähigen Metallpulver (13, 24) enthält, wobei die Teilchen durch das Material der klebenden Folie (12, 23) voneinander elektrisch isoliert sind und das klebende Material bei der Arbeitstemperatur und unter dem Arbeitsdruck verfließen kann.
2. Elektrisch leitende klebende Folie gemäß Anspruch 1 zum elektrischen Verbinden eines ersten Satzes mehrerer elektrisch leitender Bahnen (6, 22) mit einem zweiten Satz mehrerer elektrisch leitender Bahnen (7, 28), wobei jeweils eine der Bahnen mit einer aus dem ersten Satz der elektrisch leitenden Bahnen verbunden wird unter mechanischer Integration des ersten und zweiten Satzes der mehreren elektrisch leitenden Bahnen (6, 7, 22, 28), wobei das Metallpulver (13, 24) durch das klebende Material (12, 23) elektrisch isoliert ist und das Metallpulver (13, 24) eine Teilchengröße aufweist, die klein genug ist, um eine Brückenbildung von benachbarten Paaren der leitenden Bahnen (6, 7, 22, 28) beim Abflachen unter der Einwirkung des Arbeitsdruckes zu vermeiden, wobei das Metallpulver (13, 24) sowie das klebende Material beim Abkühlen auf Raumtemperatur verfestigt werden.
  3. Elektrisch leitende klebende Folie gemäß Anspruch 1 oder 2, wobei das Metallpulver (13, 24) einen Schmelzpunkt zwischen 50° und 350° hat.
  4. Elektrisch leitende klebende Folie gemäß einem der Ansprüche 1 bis 3, wobei das Metallpulver (13, 24) einen Schmelzpunkt zwischen 80° und 260° hat.
  5. Elektrisch leitende klebende Folie gemäß einem jeden der Ansprüche 1 bis 4, wobei das Metallpulver (13, 24) eine isolierende Schicht auf einer Oberfläche von jedem der Teilchen des Metallpulvers (13, 24) aufweist.
  6. Elektrisch leitende klebende Folie gemäß einem jeden der Ansprüche 1 bis 5, wobei das Metallpulver (13, 24) hergestellt ist aus einer hauptsächlich Pb und Sn enthaltenden Legierung.
  7. Elektrisch leitende klebende Folie gemäß einem jeden der Ansprüche 1 bis 6, wobei das Metallpulver (13, 24) an eine transparente leitende Elektrode aus den Oxiden von Indium und Zinn verlötbar ist.
  8. Elektrisch leitende klebende Folie gemäß einem jeden der Ansprüche 1 bis 7, wobei das Metallpulver (13, 24) aus einer hauptsächlich Pb und Sn enthaltenden Legierung, die zusätzlich noch eine aus der von Zn und den Seltenerd-elementen gebildeten Gruppe ausgewählte Komponente aufweist, hergestellt ist.
  9. Elektrisch leitende klebende Folie gemäß einem jeden der Ansprüche 1 bis 8, wobei die klebende Folie (11, 25) eine Dicke zwischen 5 µm und 200 µm aufweist.
  10. Elektrisch leitende klebende Folie gemäß einem jeden der Ansprüche 1 bis 9, wobei die klebende Folie (11, 25) 0,5 bis 50 Volumenteile des Metallpulvers (13, 24), bezogen auf 100 Volumenteile des klebenden Materials (12, 23), enthält.
  11. Elektrisch leitende klebende Folie gemäß einem jeden der Ansprüche 1 bis 10, wobei das klebende Material (12, 23) einen Schmelzflußindex nicht unter 0,001 bei der erhöhten Arbeitstemperatur aufweist.
  12. Elektrisch leitende klebende Folie gemäß einem jeden der Ansprüche 1 bis 11, wobei das klebende Material (12, 23) einen Schmelzflußindex nicht unter 0,005 bei der erhöhten Arbeitstemperatur aufweist.
  13. Elektrisch leitende klebende Schicht gemäß einem jeden der Ansprüche 1 bis 11, wobei das klebende Material (12, 23) einen spezifischen Widerstand nicht unter 10 Ohm cm aufweist.
  14. Elektrisch leitende klebende Folie gemäß Anspruch 1 oder 2, wobei die elektrisch leitende klebende Folie Teil einer Leiterplatte mit einem isolierenden Substrat (8, 21) ist, der erste Satz der mehreren elektrisch leitenden Bahnen (6, 22) auf dem Substrat (8, 21) gebildet ist und die elektrisch leitende

klebende Schicht (12, 23) auf den leitenden Bahnen (6, 22) wenigstens über einer Fläche angeordnet ist, wo der zweite Satz der mehreren elektrisch leitenden Bahnen (7, 28) mit dem ersten Satz der elektrisch leitenden Bahnen (6, 22) verbunden werden soll.

- 5 15. Elektrisch leitende klebende Folie gemäß Anspruch 14, wobei das Substrat (8, 21) aus Glas hergestellt ist.
- 10 16. Elektrisch leitende klebende Folie gemäß Anspruch 14 oder 15, wobei die klebende Folie (11, 25) über den ersten Satz der mehreren elektrisch leitenden Bahnen (6, 22) und das Substrat (8, 21) geschichtet ist.
- 15 17. Elektrisch leitende klebende Folie gemäß Anspruch 1 oder 2, wobei die elektrisch leitende klebende Folie Teil einer elektrischen Verbindungsstruktur ist, wobei der erste Satz mehrerer elektrisch leitender Bahnen (6, 22) auf einem Substrat (8, 21) gebildet ist und wobei das Aufschmelzen und Abflachen unter Oberflächen-Kontaktbedingungen und Anwendung einer bestimmten erhöhten Arbeitstemperatur erfolgt, die höher als der Schmelzpunkt des Metallpulvers (13, 24) liegt, sowie ein bestimmter Arbeitsdruck zwischen dem ersten und dem zweiten Satz der elektrisch leitenden Bahnen (6, 7, 22, 28) ausgeübt wird, wodurch das klebende Material (12, 23) schmilzt, verfließt und teilweise zwischen dem ersten und dem zweiten Satz der elektrisch leitenden Bahnen (6, 7, 22, 28) ausgestoßen wird unter mechanischer Integration des ersten und zweiten Satz der elektrisch leitenden Bahnen (6, 7, 22, 28).
- 20 18. Elektrisch leitende klebende Folie gemäß Anspruch 17, wobei der zweite Satz der mehreren elektrisch leitenden Bahnen (7, 28) auf einem integrierten Halbleiterchip (14, 30) gebildet ist.
- 25 19. Elektrisch leitende klebende Schicht gemäß Anspruch 17 oder 18, wobei der zweite Satz der mehreren elektrisch leitenden Bahnen (7, 28) eine Vielzahl von Anschlußelektroden elektronischer Teile ist.
- 30 20. Elektrisch leitende klebende Folie gemäß einem jeden der Ansprüche 17 bis 19, wobei die elektronischen Teile integrierte Halbleiterchips sind.
- 35 21. Elektrisch leitende klebende Folie gemäß Anspruch 19 oder 20, wobei diese weiterhin eine flexible Folie aufweist, die Verbindungsabschnitte von den ersten und den zweiten Bahnen überdeckt.
- 40
- 45
- 50
- 55

FIG. 1

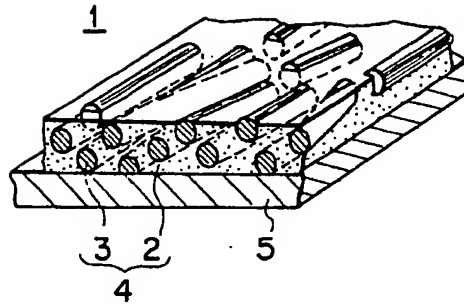


FIG. 2

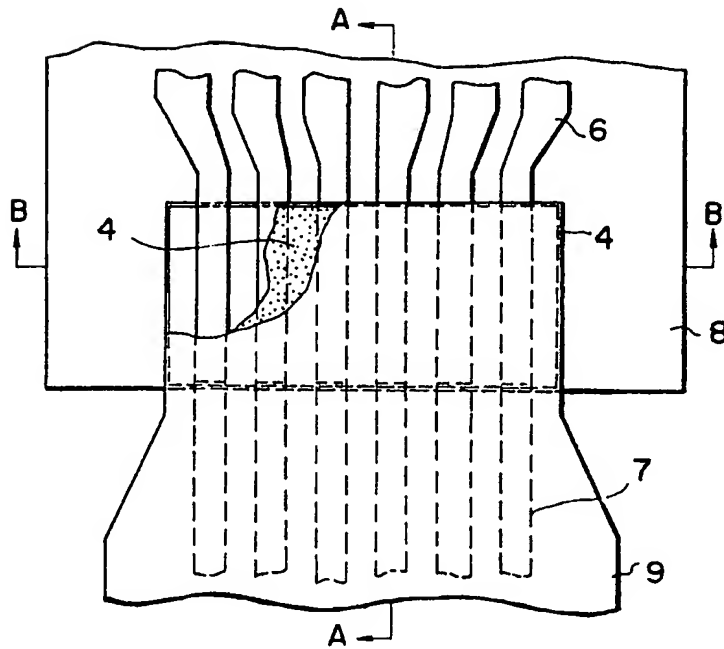


FIG. 3

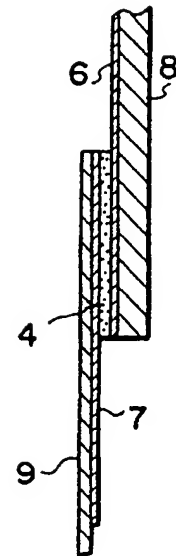


FIG. 4

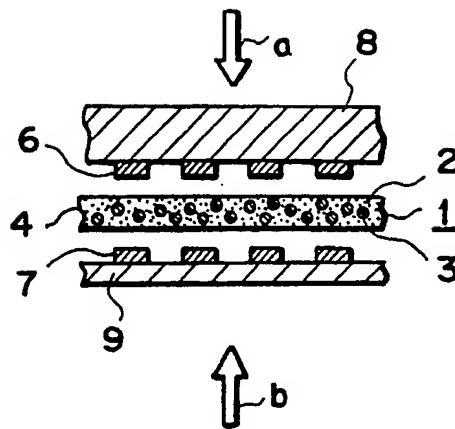


FIG. 5

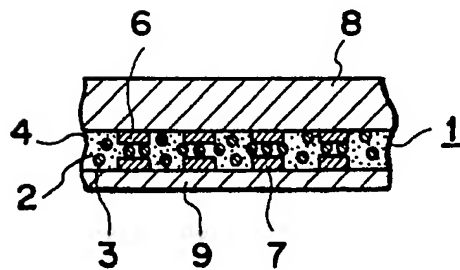


FIG. 6

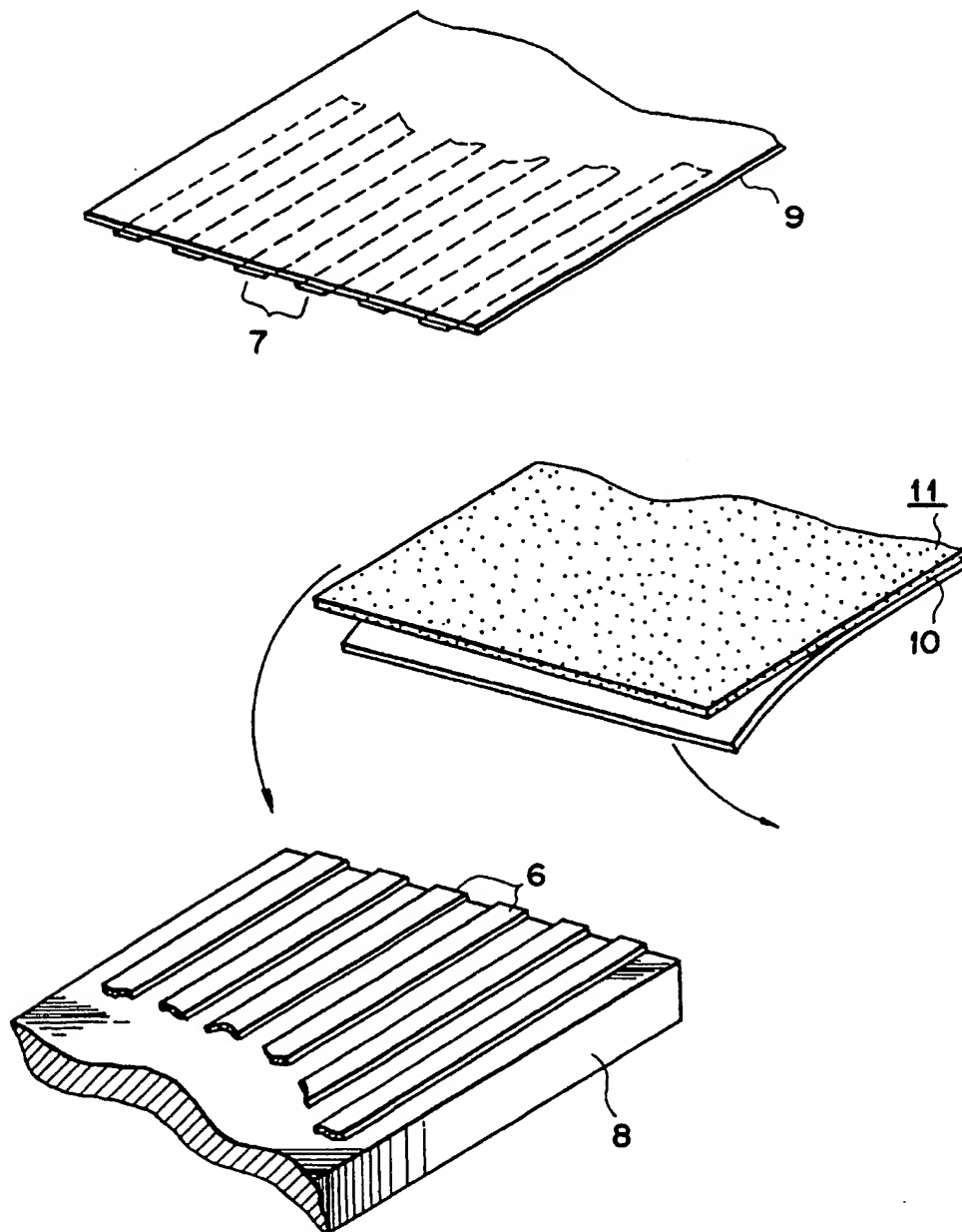




FIG. 7

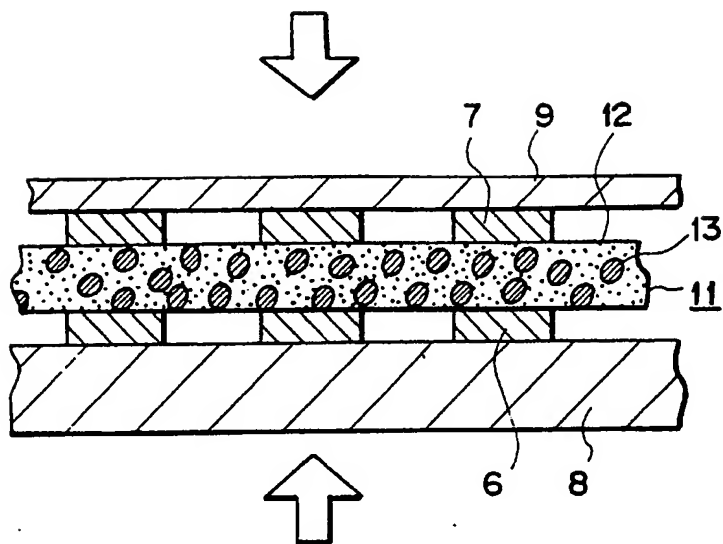


FIG. 8

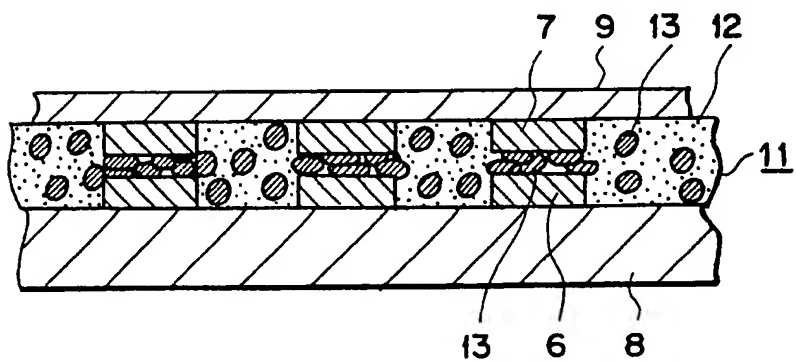


FIG. 9

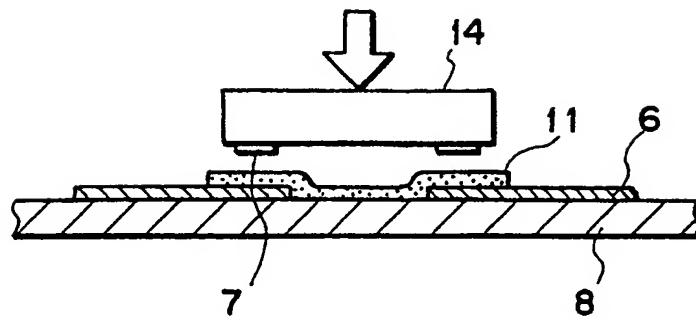


FIG. 10

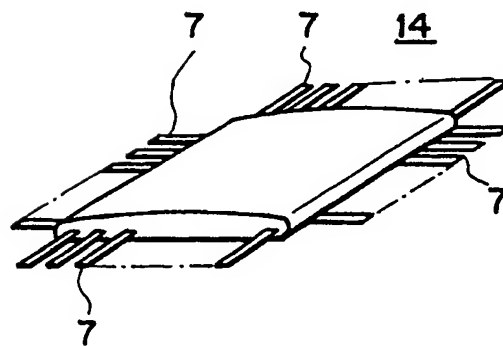


FIG. 11

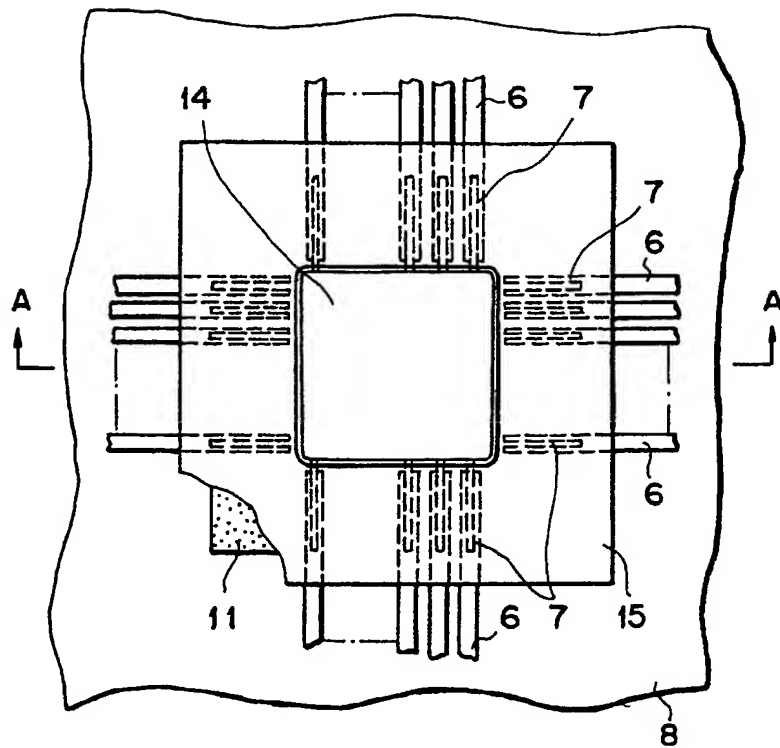


FIG. 12

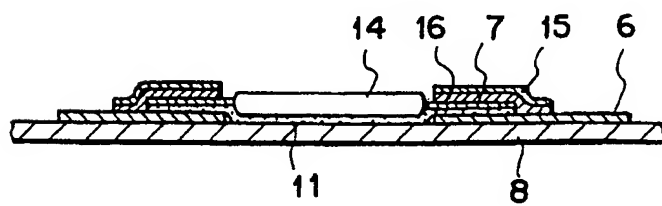


FIG. 13

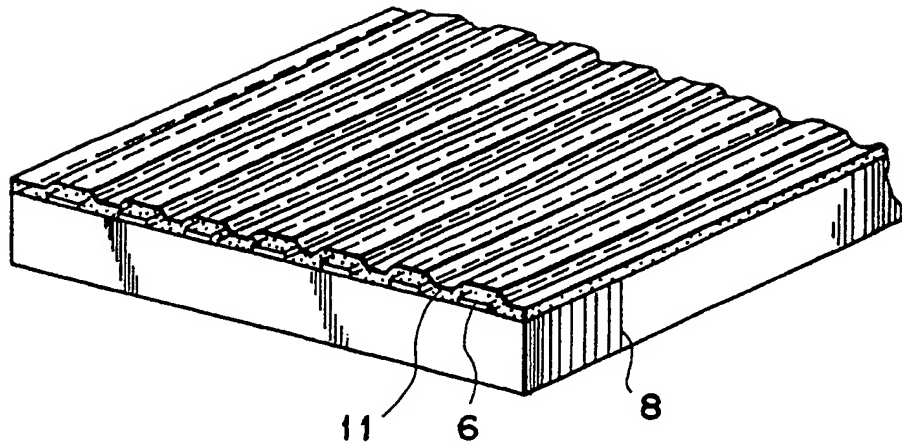


FIG. 14

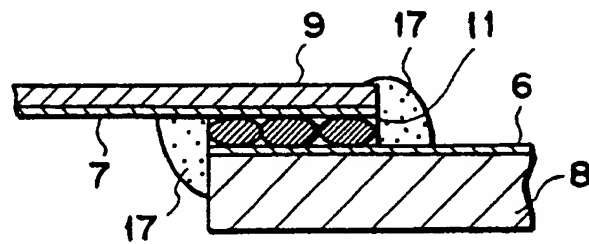


FIG. 15

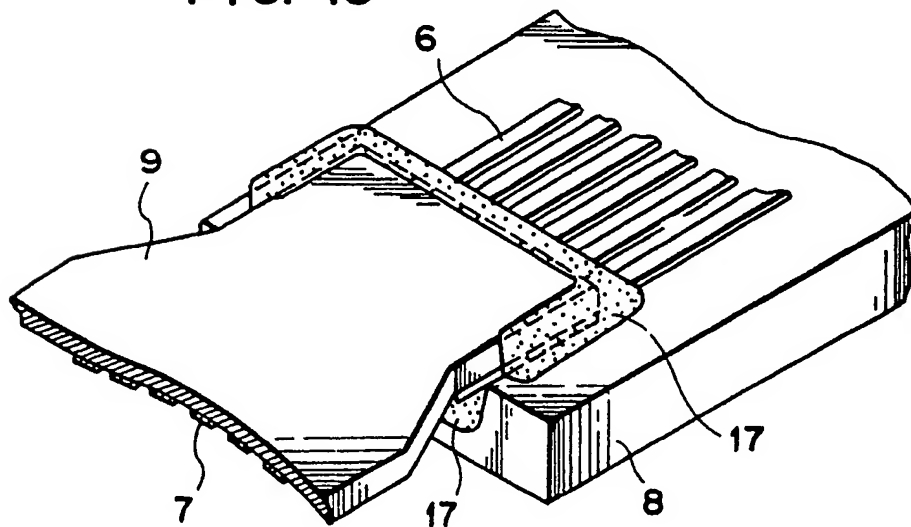


FIG. 16

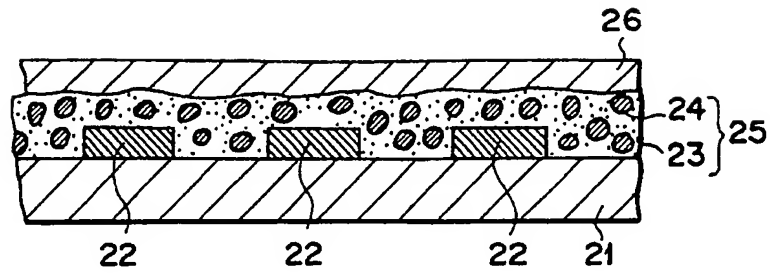


FIG. 17

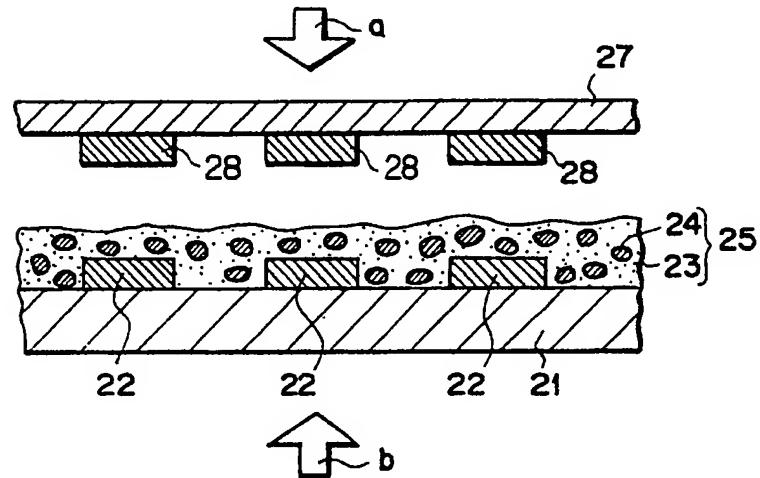


FIG. 18

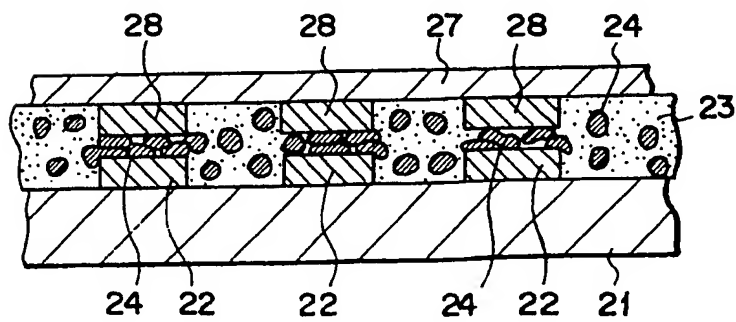


FIG. 19

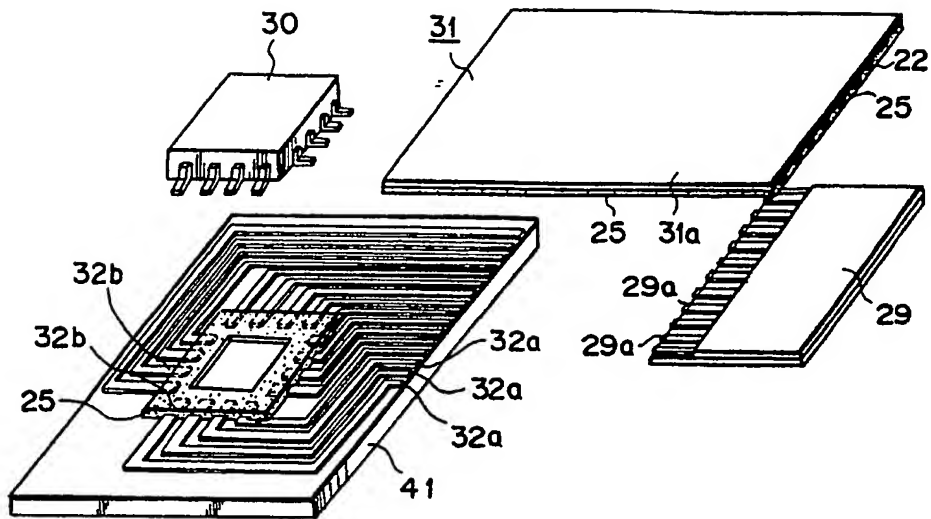
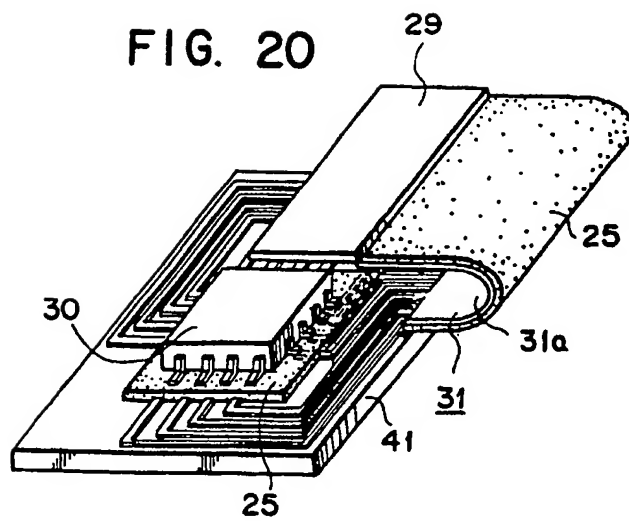


FIG. 20



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